(12) UK Patent Application (19) GB (11) 2 277 700 (13) A

(43) Date of A Publication 09.11.1994

(21) Application No 9408612.1

(22) Date of Filing 29.04.1994

(30) Priority Data
(31) 4314440 (32) 03.05.1993 (33) DE

(51) INT CL[5]
B04B 9/04 9/12

(52) UK CL (Edition M)
B2P P9A3A P9D1

(56) Documents Cited
GB 1182940 A GB 1038850 A GB 0673482 A
GB 0247004 A

(58) Field of Search
UK CL (Edition M) B1D DMBD , B2P P9A2A P9A3A P9D1
INT CL[5] B04B 9/04 9/12

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(54) Centrifugal separator

(57) A centrifugal separator with full-load starting comprises a housing (1) enclosing a rotary separator drum (3) and a drive motor whose rotor (2) is directly and rigidly connected to the drum by a drive shaft (4). The drum, rotor and shaft form a rotational system which is non-resiliently mounted, by bearings (7, 8), in a stator (14) of the motor. The stator is rigidly attached to a bearing support (5) located on a level between the drum and motor and connected to the housing (1) by way of resilient elements (9) which radially and axially locate the rotational system relative to the housing, but permit oscillation due to, for example, drum imbalance. In Fig. 1 the rotational system is solely supported by elements (9), but in Fig. 2 the shaft also extends downwards from the motor and is supported non-resiliently but rotatably and oscillatably from the housing. The drum may be mounted directly on the motor shaft or on an extension rigidly secured thereto.

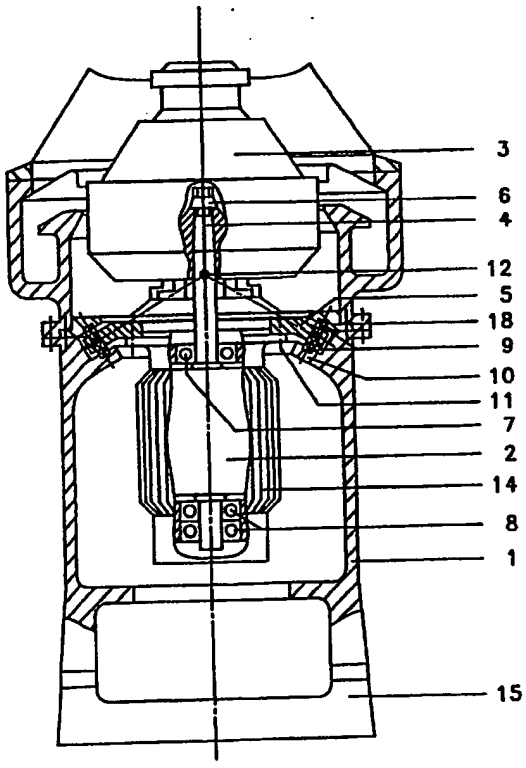

Fig. 1

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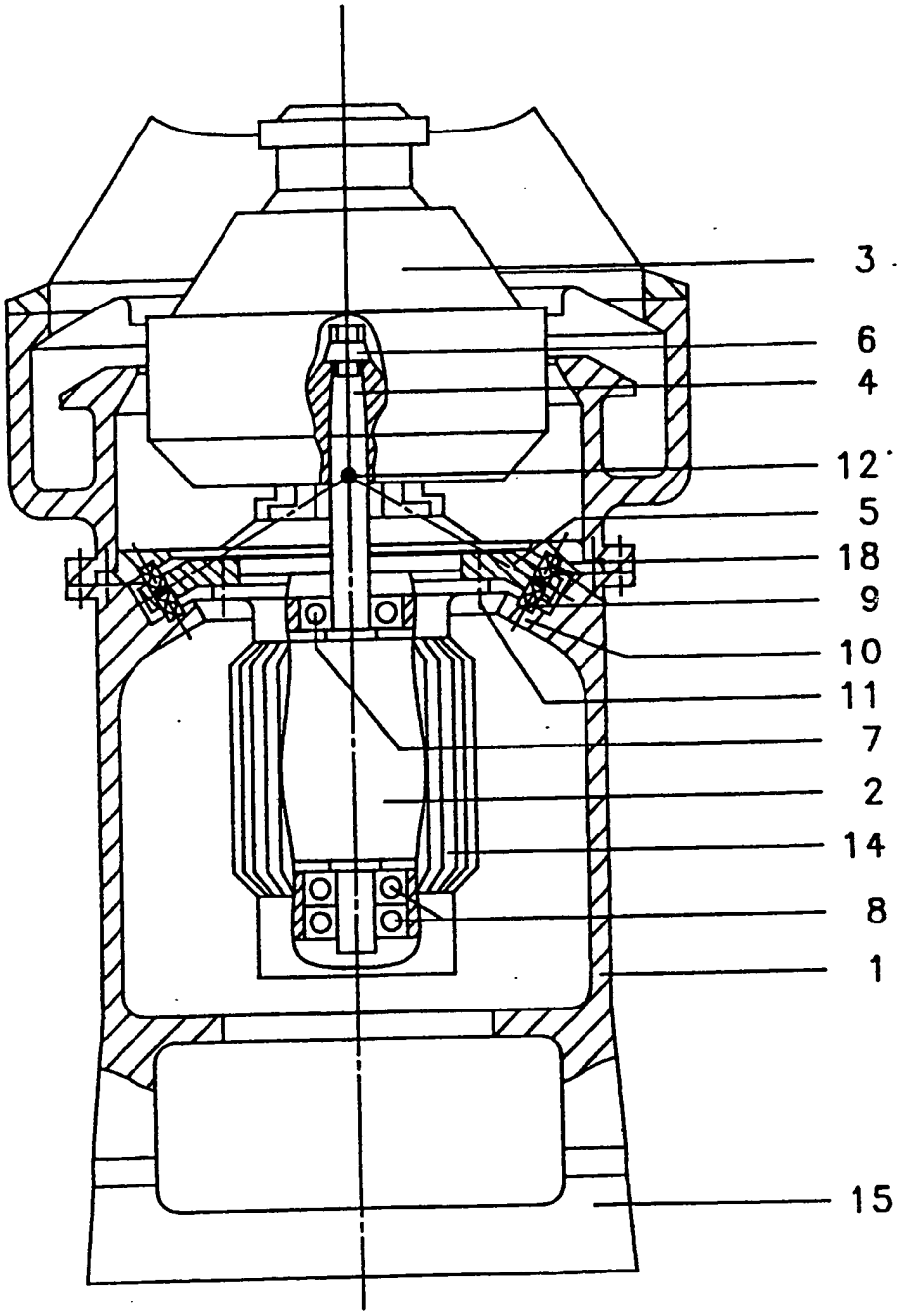

Fig. 1

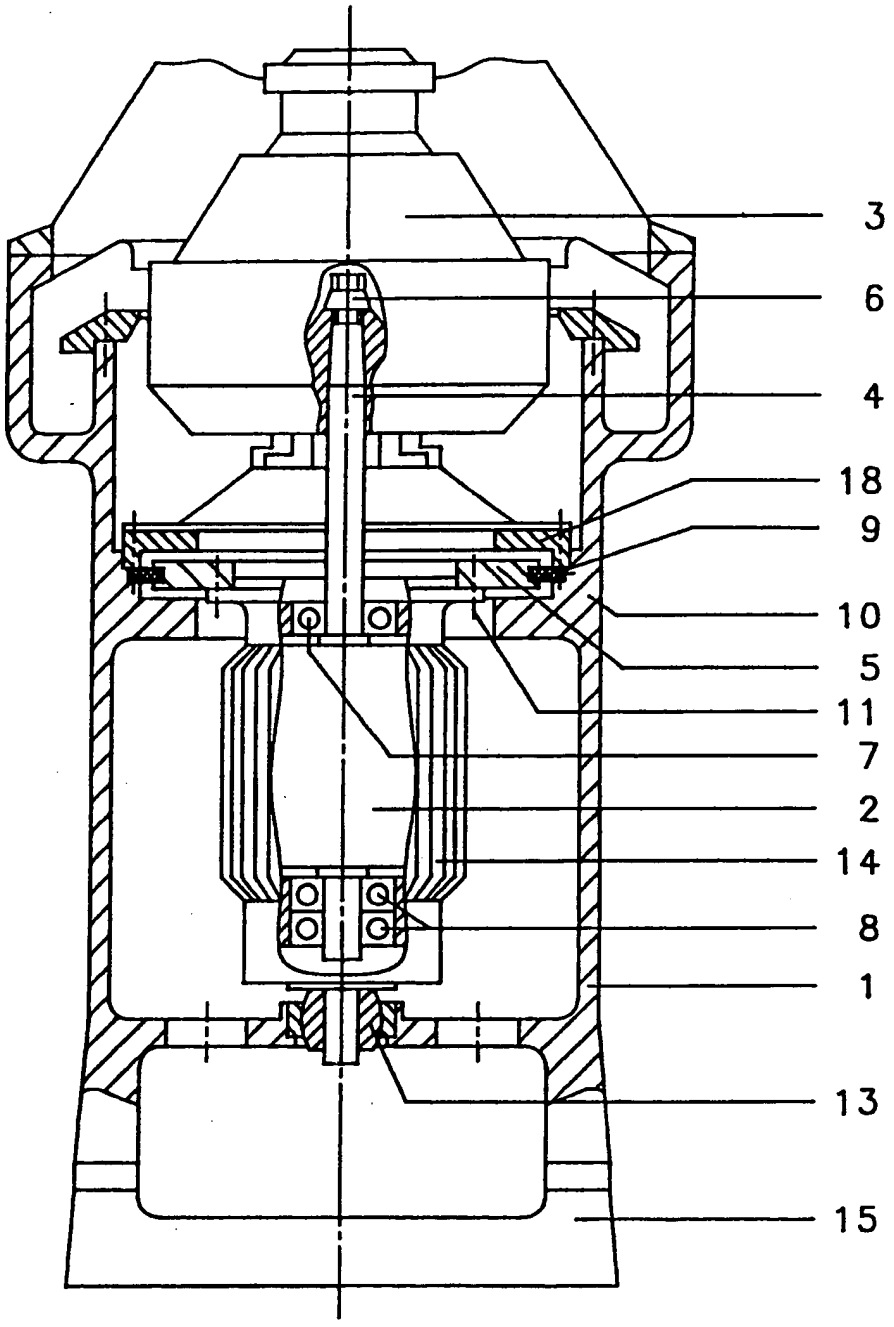

Fig. 2

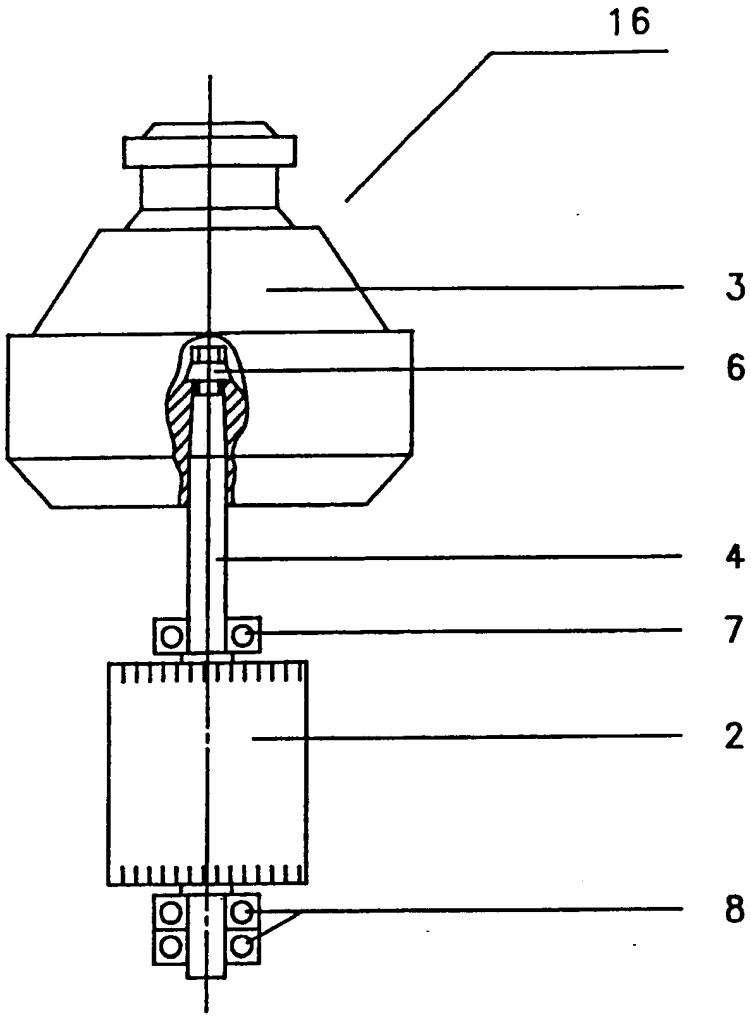

Fig. 3

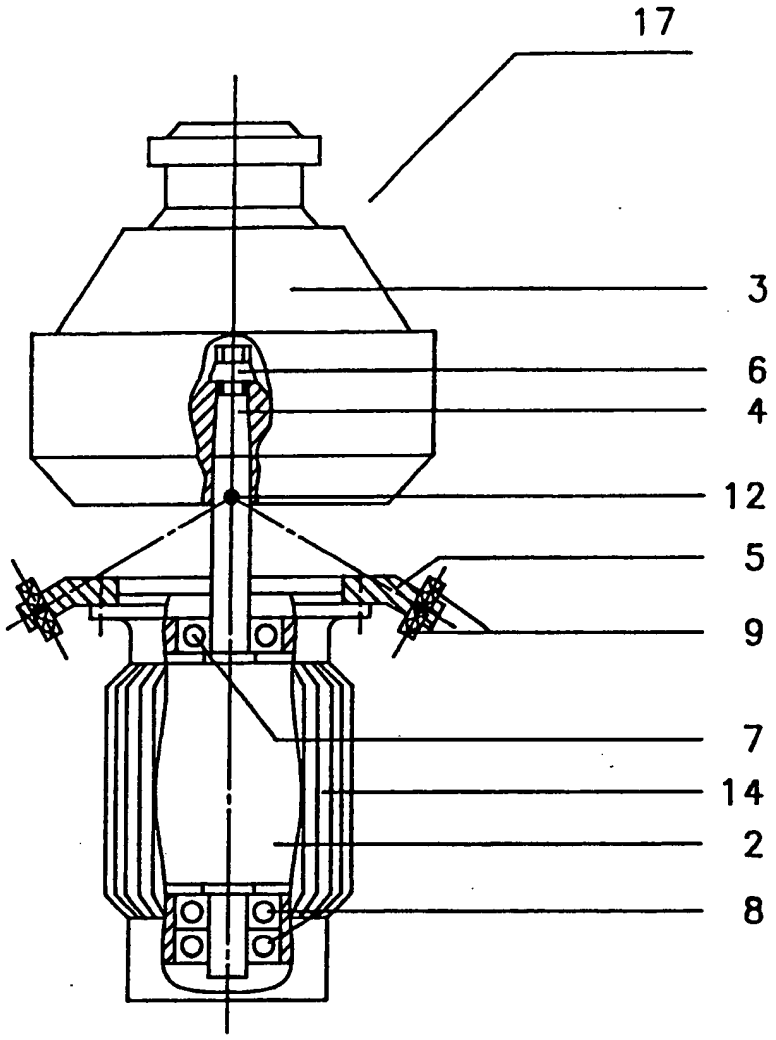

Fig. 4

CENTRIFUGAL SEPARATOR

The present invention relates to a centrifugal separator with full-loading starting.

It is known, for example from DE-OS 20 62 131, for centrifugal separators with full-load starting to be constructed with a stationary housing having deflecting elements connected therewith and with a drum which rotates in the housing and is firmly connected with a vertical drive spindle. The spindle is driven by a horizontally arranged motor, the drive power of which is transmitted by way of a clutch and a gear to the spindle.

It is also known, from DE-PS 31 25 832, to drive centrifugal separators by a vertically arranged motor. In that case the drive power is transmitted by way of a belt drive to the vertically arranged drive spindle of the separator.

In both variants, the drive spindle of the drum is mounted to be pendulating relative to the separator housing and to be rotatable in bearing systems which absorb the axially and radially acting forces of the rotating drum.

These known drive variants for centrifugal separators with full-load starting are expensive to manufacture due to the transmission of the drive power of the motor to the drum drive spindle and require regular maintenance and service attention to the elements transmitting the driving power, such as clutch, gears or belt drive.

Because of the full-load starting of this kind of centrifugal separator, it is necessary that the motors used are designed for more than the actual operating performance, so as to ensure travel-free starting of the separator and, in the case of a self-opening separator, compensation for drop in rotational speed of the drum due to brief opening thereof for the purpose of sludge discharge. Oversizing of the motor negatively influences operating economics and the cost of the separator itself.

For small centrifuges with low drum mass, for example laboratory centrifuges and milk centrifuges, where no full-load starting is required, it is known to mount the drum directly on the drive shaft of the motor or to connect the drive spindle of the drum with the drive shaft of the motor by a friction coupling.

A small centrifuge is described in CH 253 463, in which the motor is mounted to be capable of oscillation with the centrifuge housing by means of resilient elements, for example of rubber, in order not to transmit oscillations, which are caused inter alia by residual imbalance of the drum, to the housing. The bearing of the motor shaft, which is at the same time designed as the drive spindle of the drum, is mounted in the motor housing resiliently relative thereto by the interposition of a rubber ring. This resilient arrangement of the motor shaft bearing and a resilient motor suspension in this kind of centrifuge is sufficient to compensate for the deflections of the drum resulting from, for example, precession movement of the drum and possible residual drum imbalance. However, this is only possible because the centre of

mass of the entire system consisting of the drum with its relatively low mass and the relatively large motor with its motor shaft, can be located below the drum reception point of the drive spindle, in this case the motor shaft. In addition, by virtue of its own low centre of gravity the drum can be placed freely onto the drive spindle, whereby no rigid mechanical association of the suspension point with the centre of gravity is necessary, so that movements of the drum and its centre of mass have no influence on the drive spindle and its bearing.

In addition, small centrifuges of the afore-mentioned kind are described in US-PS 2 587 418, US-PS 2 265 053 and FR-PS 1 287 551, which are in their essential construction, especially in the resilient arrangement of the motor and the resilient bearing of the drive spindle of the drum, similar to CH-PS 253 463. However, in these centrifuges the arising axial forces are not absorbed by the motor bearing, as illustrated in CH-PS 253 463, but through a support point which is arranged in the housing below the motor and in which the entire system consisting of the drum, the drive spindle and the motor is resiliently received.

The known constructions of drive spindle bearing for small centrifuges, and the arrangement of the motor in the centrifuge housing relative to the rotating system and the housing in consequence of a directly driven drive spindle of the drum, are not transferrable to a centrifugal separator with full-load starting, in view of the different radial and axial loading. In such separators the drum mass is a multiple by comparison with the drive motor, and

the drive spindle is usually mechanically connected with the drum, for example by a nut. Moreover, the centre of mass of the rotating system is very high in the case of centrifugal separators with high drum mass and relatively low motor weight.

On the other hand, due to the constructional formation of the complete drum, its fastening with the drive spindle is effected below or near the centre of mass of the drum, so that an axial, mechanically rigid connection must be provided between the drum and the drive spindle. This connection, for example by means of a nut, leads to all deflections caused by the drum, for example due to residual imbalance, irregular sludge deposit in the drum and drum precession movement, being transmitted directly by way of the drive spindle and thereby to its bearing.

This means that transfer of the direct drive system used in small centrifuges to centrifugal separators with a large drum mass does not ensure adequate stability of the rotating system. Susceptibility to fault due to excess loading of the drive spindle bearing and the entire rotating system is substantially increased and problems caused by an overload during the operation of the separator cannot be excluded.

In DE-OS 37 14 627 there is described a centrifugal separator in which the drive spindle of a drum with a high mass is driven directly by a frequency-controlled motor. This drive provides a gently and uniform full-load starting of the drum without the motor having to be designed to be larger than is required for the intended operation of the separator. However, the bearing of the rotating system

has the disadvantages which have been explained above, so that this arrangement was not used for driving the drive spindle of a high-mass drum without gearing.

There thus remains a need for a centrifugal separator, with a drive shaft driven directly by a motor, in which excess loading of mounting means of the drive shaft may be avoided, transmission of drum deflections by way of the drive shaft to its mounting may be prevented and a system stably rotating in a housing may be created.

According to the present invention there is provided a centrifugal separator with full-load starting and a stationary housing with firmly connected deflecting elements and a drum, which rotates in the housing and is firmly connected with a vertical drive spindle, which is driven directly by a motor with full-load starting and mounted in a bearing system which absorbs the radially and axially acting forces of the rotating system consisting of the drive spindle, the drum and a rotor of the motor, wherein the rotating system is mounted inelastically, and the rotating system, a bearing support, which is arranged between a stator of the motor and the drum, and the stator of the motor, which is rigidly connected with the bearing support, is constructed as a constructional and oscillation-technical unit, which is elastically connected - subject to consideration of the centre of mass of the unit - axially and radially by way of the bearing support with the housing.

It is that case advantageous if elastic elements, which absorb the radial and axial forces between the housing and the bearing support, are so arranged tangentially on a circle about the centre of mass of the unit that one of the lines of action of the restoring forces passes through the centre of mass of the unit.

If it should be desired to relieve the elastic elements of the axially acting forces of the unit, the bearing support can be constructed in its vertical extent to below the motor and fixed in an inelastic and angularly movable foot point of the housing. This construction is to be recommended particularly for very large drums.

In the light of functional conditions, it may be desirable for elastic elements between the bearing support and the housing to be arranged spatially in one plane of the bearing support.

By virtue of such a construction of the separator, a stably rotating drum with full load starting and indirectly driven drive spindle of the drum is created. The loadings which can arise due to deflection of the drum by inter alia residual imbalance or precession movement are not, in spite of the rigid or mechanical fastening of the drum to the drive spindle, transferred to the bearing system of the rotating system, but are merely conducted through the bearing system and absorbed by the elastic elements and compensated for due to the position relative to the centre of mass of the unit and the kind of the elements.

Manufacturing costs may be considerably reduced due to the absence of intermediate elements, such as gear and clutch, or of a belt drive transmitting the driving power, and the motor can be designed exclusively according to its intended purpose. At the same time, such a centrifugal separator may be substantially service-free and insusceptible to faults.

Embodiments of the present invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a schematic sectional view of a first centrifugal separator embodying the invention;

Fig. 2 is a schematic vertical sectional view of a second centrifugal separator embodying the invention;

Fig. 3 is a sectional view of the rotating system in the separator of Fig. 1; and

Fig. 4 is a sectional view of a constructional oscillation-technical system in the separator of Fig. 1.

Referring now to the drawings, there is shown in Fig. 1 a centrifugal separator comprising a housing 1, a frequency-controlled motor with a rotor 2, a stator 14 and a prolonged motor shaft, which is constructed at the same time as a drive spindle 4, a drum 3 and a bearing support 5, which is arranged between the drum and the stator and at the circumference of which resilient elements 9 are arranged. These elements are resiliently connected with a bracket 10, which is integrally connected with housing 1. The drive spindle 4, which in this case is the prolonged motor shaft, is mounted in the motor housing in a specially constructed bearing system consisting of a radial bearing 7 and oblique bearings 8 and is provided at its upper end with a receptacle cone and a thread, on which the drum 3 is placed and mechanically and frictionally secured thereto by means of a nut 6.

The housing 1 is mounted on a base plate 15, which is let into a foundation and connected therewith by fastening means.

Fig. 2 shows a construction with, below the motor, a radially and axially inelastic foot point 13, which is connected with the housing 1 and in which the bearing support 5, which effectively extends down to below the motor housing, is inelastically mounted to be angularly movable. In the construction according to Fig. 2, the stator 14, which is rigidly connected with the bearing support 5, of the motor is utilised as a prolongation of the bearing support.

This construction is particularly preferred for higher axial forces.

Fig. 3 shows the rotating system 16 by itself, namely the rotor 2 of the motor, the motor shaft mounted in the elastically constructed bearing system, which consists of the radial bearing 7 and oblique bearings 8,and forming the drive spindle 4, and the drum 3 connected to the spindle 4 by the nut 6.

Fig. 4 shows a constructional oscillation-technical unit 17, which consists of the rotating system 16, the stator 14 of the motor and the bearing support 5. The support 5 is arranged between the drum 3 and the motor and rigidly connected with the stator 14. The resilient elements 9 are arranged at the circumference of the support 5, subject to consideration of the centre of mass 12 of the unit. The elements 9 are so arranged tangentially on this circle about the centre of mass 12 that the line of action of one of the restoring forces always passes through the centre of mass.

The elements 9 are distributed uniformly around the circumference of the bearing support 5.

It is also possible to arrange one compact resilient element 9 encircling the circumference at the bearing support 5.

This inelastic constructional unit 17 is placed by way of the bearing support 5 and the elements 9 onto the bracket 10 connected with the housing 1 and pressurably connected therewith under biassing of the elements 9 by a pressure ring 18 and pins (indicated as lines of force in Figs. 1 and 2).

Due to the inelastic constructions of the rotating system 16 and the unit 17, which is connected elastically by way of the bearing support subject to consideration of the centre of mass 12 in the housing 1, the axially and radially acting forces, which are caused by the rotating drum 3 rigidly connected with the drive spindle 4, are conducted through the inelastic bearing system of the drive spindle 4 and absorbed by the resilient elements lying tangentially about the centre of mass 12 of the unit 17.

In the case of construction with the inelastic foot point 13 arranged in the housing 1, the resilient elements 9 absorb only the radially acting forces and the elements can be arranged as illustrated in Fig. 2. In this case, the axially acting forces are absorbed by the foot point 13.

Although the drive spindle 4 and the motor shaft are, in the described embodiments, designed as an undivided component, it is possible to construct the motor shaft and the drive spindle as two separately mounted components mechanically connected together. In this case, the two bearing systems, that of the drive spindle 4 and that of the motor shaft, are to be constructed inelastically, as described for an undivided spindle.

CLAIMS

1. A centrifugal separator with full-load starting comprising a housing, a rotary separator drum arranged in the housing, a motor having a rotor and a stator and able to provide full-load starting, an upright drive shaft rigidly connected to the drum and directly driven by the motor, and mounting means mounting the shaft in such a manner as to at least partly absorb radial and axial forces generated by a rotational system comprising the drum, rotor and shaft, the rotational system being non-resiliently mounted in an oscillatable constructional unit comprising the rotational system, the stator and a bearing support disposed between the stator and drum and rigidly connected to the stator, and the unit being resiliently connected to the housing in axial and radial directions by way of the bearing support at a location having a predetermined relationship to the centre of mass of the unit.

2. A separator as claimed in claim 1, comprising resilient means so arranged between the bearing support and the housing on a circle around the unit that a line of action of the restoring force of the resilient means passes through the centre of mass of the unit.

3. A separator as claimed in claim 1 or claim 2, wherein the bearing support is additionally non-resiliently connected to the housing at a point below the motor by way of connecting means so as to be angularly movable relative to the housing.

4. A separator as claimed in claim 2, the resilient means being arranged in a single plane.

5. A separator as claimed in any one of the preceding claims, wherein the drive shaft is a single individual shaft attached to both the drum and the rotor.

6. A separator as claimed in any one of claims 1 to 4, wherein the drive shaft is non-resiliently but detachably connected to a shaft attached to the rotor.

7. A separator substantially as hereinbefore described with reference to Figs. 1, 3 and 4 of the accompanying drawings.

8. A separator substantially as hereinbefore described with reference to Fig. 2 of the accompanying drawings.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report) -12-	Application number GB 9408612.1
Relevant Technical Fields (i) UK Cl (Ed.M) BID (DMBD) B2P (P9A2A, P9A3A, P9D1) (ii) Int Cl (Ed.5) B04B (9/04, 9/12)	Search Examiner R T HAINES Date of completion of Search 1 JUNE 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-8

Categories of documents

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A:	Document indicating technological background and/or state of the art.	**&:**	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1182940	(M S E HOLDINGS LTD)	1, 2, 4, 5, 6
X	GB 1038850	(VOIGT)	1, 2, 5
X	GB 0673482	(ELECTROLUX CORP)	1, 2, 3, 5
X	GB 0247004	(SIEMENS GES)	1, 2, 5

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